Reclassification of the nearest quasar pair candidate: SDSS J15244+3032 – RXS J15244+3032

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Abstract We present optical spectroscopy of the nearest quasar pair listed in the 13$^{\rm th}$ edition of the Véron-Cetty & Véron catalogue, i.e. the two quasars SDSS J15244+3032 and RXS J15244+3032 (redshift $z \approx 0.27$, angular separation $\Delta\theta \approx 7''$, and line–of–sight velocity difference $\Delta V \approx 1900$ km/s). This system would be an optimal candidate to investigate the mutual interaction of the host galaxies with ground based optical imaging and spectroscopy. However, new optical data demonstrate that RXS J15244+3032 is indeed a star of spectral type G.

This paper includes data gathered with the Asiago 1.82 m telescope (Cima Ekar Observatory, Asiago, Italy).

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1 Introduction

In the last years, increasing attention has been given to the search for quasar pairs (i.e., two quasars close in the sky and with almost the same redshift) in order to assess the role of galaxy interactions in quasar ignition (e.g., Hennawi et al. 2006, 2010; Myers et al. 2007a,b, 2008; Foreman et al. 2009; Shen et al. 2010; Decarli et al. 2010; Farina et al. 2011; Kayo & Oguri 2012; Richardson et al. 2012). However, the discovery of these systems is challenging. Even the large spectroscopic quasar catalogue of Schneider et al. (2010) which holds more than ~ 100000 objects from the 7th data release of the Sloan Digital Sky Survey (SDSS, Abazajian et al. 2009), contains 22 quasars with angular separation $\Delta\theta < 15''$, and only 12 with $\Delta\theta < 10''$. This arises mainly as an effect due to the so–called fiber collision limit: the finite size of the fiber plugs prevents the collection of spectra of more than one object with separation below $55''$ within the same SDSS plate (Blanton et al. 2003).

In order to increase the number of known small separation pairs, we have scrutinised the 13$^{\rm th}$ edition of the Véron-Cetty & Véron quasar catalogue (Véron-Cetty & Véron 2010, hereafter, VCV10), where the effects of the fiber collision limits should be mitigated by the inhomogeneous origin of the listed sources. In this paper we present compelling evidences that one of the discovered systems: SDSS J15244+3032 and RXS J15244+3032 with $\Delta\theta = 7\farcs6$ is instead a quasar–star pair.

Throughout this paper we consider a concordance cosmology with $H_0 = 70$ km/s/Mpc, $\Omega_{\rm m} = 0.3$, and $\Omega_\Lambda = 0.7$.

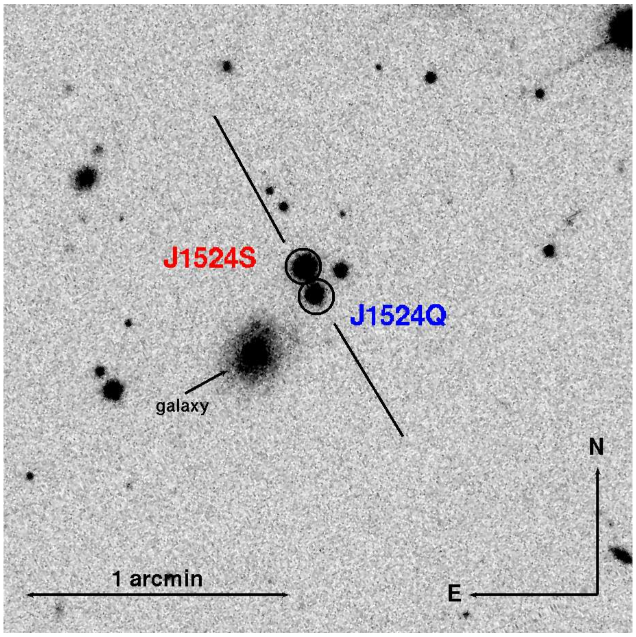

Fig. 1 The field of J1524QS as imaged in r–band by SDSS. The slit orientations adopted in our observation is also plotted. The arrow points to the galaxy at z = 0.0626 located at 19.″0 from J1524Q

2 J1524QS

With the aim of discovering new close physical pairs of quasars we investigated the VCV10 catalogue which contains more than 130000 quasars with known redshifts. We found 58 pairs of quasars with projected separation pd $\leq$ 50 kpc (at the redshift of the nearer quasar), 28 of which are physical pairs (i.e. have line–of–sight velocity difference $\Delta V \leq 2000$ km/s, see Hennawi et al. 2006) and thus are well suited to the study of interacting systems. In fact the explored projected scales (pd $<$ 50 kpc) are those where the quasar activity is expected to be triggered by dissipative interaction events, and the probability that they are due to chance superpositions is rather low (Hennawi et al. 2006; Myers et al. 2007a,b; Foreman et al. 2009; Farina et al. 2011; Kayo & Oguri 2012). Of particular interest are the lower redshift systems, for which ground based data allow direct investigation of the effects of mutual interaction and of the galactic environment on triggering the quasar activity (e.g., Mortlock et al. 1999; Green et al. 2010, 2011).

In order to confirm the quasar association and to measure the relative systemic velocities from [OIII] lines (see §4) we observed with the 1.82 m Asiago telescope the two quasars SDSS J15244+3032 (hereafter J1524Q) and RXS J15244+3032 (hereafter J1524S), the nearest pair we have found (see Figure 1). In the VCV10 catalogue, it appears as a system of two bright radio quiet quasars separated in the sky by $\Delta\theta = 6.''5$ with redshift z = 0.274 for J1524Q (Adelman-McCarthy et al. 2006) and z = 0.282 for J1524S (Zhao et al. 2000). The two sources were detected in IR by the Two Micron All Sky Survey (2MASS, Skrutskie et al. 2006) with magnitudes: J = 15.28, H = 14.47, and K = 13.50 for J1524Q, and J = 14.18, H = 13.68, and K = 13.70 for J1524S. A source is present in the ROSAT All–Sky Survey Bright Source Catalogue (Voges et al. 1999) at RA=15:24:28.6, DEC=+30:32:35. Both J1524Q and J1524S are within the positional error of 12″ ($\sim$ 2″ from J1524Q and $\sim$ 9″ J1524S).

It is worth noting the presence of a galaxy at redshift z = 0.0626 (RA=15:24:30,DEC=+30:32:24.2, Aihara et al. 2011, see Figure 1) located at 19.″0 from the quasar J1524Q. The corresponding projected separations of 23 kpc makes J1524Q a viable candidate to investigate the absorption features that the gaseous halos of the galaxy imprint on its spectra (see e.g., Bahcall & Spitzer 1969; Steidel & Sargent 1991; Chen et al. 2001, 2010; Adelberger et al. 2005; Farina et al. 2012). Most prominent metal features are located in the Near UV, for instance the MgII doublet and the MgI line are shifted at 2974 Å and at 3031 Å, respectively. Thus future observations with instruments like Hubble Space Telescope spectrographs STIS and COS, could increase the small number of metal absorption systems known at redshift z < 0.1, where exquisite details of the galaxy population have been recorded (see e.g., Kacprzak et al. 2011; Landoni et al. 2012).

3 Spectroscopic Data

J1524Q and J1524S were observed with the 1.82 m Asiago telescope located at the Cima Ekar Observatory on 20th April 2010. Data were gathered with the Asiago Faint Object Spectrograph and Camera (AFOSC) mounted in long–slit spectroscopy configuration with grism #4 and 2.″1 slit in the wavelength range from $\sim$ 4300 Å to $\sim$ 6700 Å. This yields a spectral resolution of R $\sim$ 300. The targets are rather bright, thus the exposure time of 1800 s (splitted into 3 exposures of 600 s each) with a seeing of 2.″5 achieved an average signal–to–noise ratio per pixel of $\sim$ 30. The position angle of the slit was oriented so that the spectrum of the two objects could be acquired simultaneously (see Figure 1).

Standard `IRAF`[1] tools were adopted in the data reduction. Bias subtraction, flat field correction, image

[1] `IRAF` is distributed by the National Optical Astronomy Observatories, which are operated by the Association of Universities for Research in Astronomy, Inc., under cooperative agreement with the National Science Foundation.

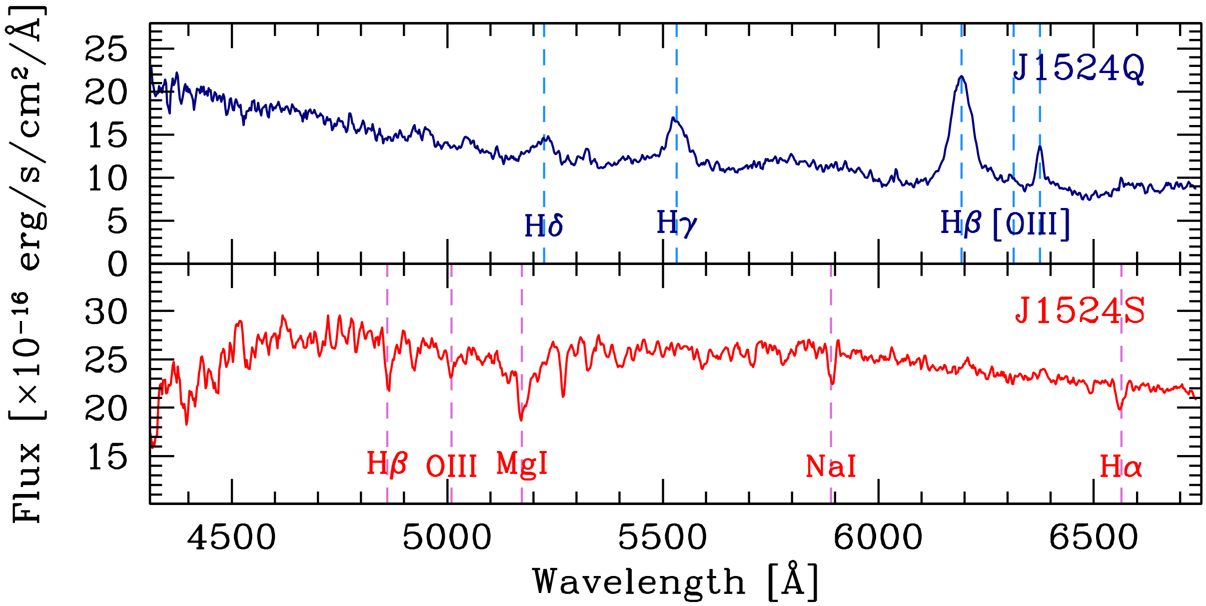

Fig. 2 The spectra of J1524Q (Top Panel) and J1524S (Bottom Panel) collected with AFOSC at the Asiago Observatory. Most prominent absorption/emission lines are marked

alignment and combination were performed with the `ccdred` package. Cosmic rays were cleaned by combining different exposures with the `crreject` algorithm. The `twodspec` and the `onedspec` packages were employed for the spectral extraction, the background subtraction and the calibrations both in wavelength and in flux. Residuals in wavelength calibrations are ~ 0.2 Å. The spectra obtained are presented in Figure 2.

4 Reclassification of the pair

The spectra of J1524S clearly shows a number of absorption features, the most noticeable of which are the rest–frame hydrogen and metal lines, indicating that it is likely a star of spectral type G (see Figure 2). The erroneous classification of the source is confirmed by the study of Pickles & Depagne (2010), who, from the analysis of the 2MASS and SDSS photometry, estimate that this object is a K0V star. We can argue that, although the finding chart published by (Zhao et al. 2000) seems to point to J1524S, the authors have probably switched the two sources, and the X–ray emission observed by ROSAT was indeed associated with J1524Q. This is also supported by the lack of other sources within 20″ from J1524S that have colour consistent with those of a quasar at $z \sim 0.28$.

It is well known that the different quasar emission lines can lead to redshift that differ by up to 1000 km/s (e.g., Tytler & Fan 1992). The most reliable estimate of the systemic redshift (z_{sys}) comes from narrow forbidden lines, the most prominent of which are the [OIII] doublet at $\lambda = 4949$ Å and $\lambda = 5007$ Å (e.g., Bonning et al. 2007; Hewett & Wild 2010). By measuring the position of the $[OIII]_{\lambda 5008}$ line in our spectrum of J1524Q, we obtain $z_{sys} = 0.2735 \pm 0.0003$ (see Table 1). This agrees to 200 km/s with the systemic redshift inferred from the SDSS spectrum by Hewett & Wild (2010, $z_{sys} = 0.2743 \pm 0.0004$). The two redshift estimates are therefore marginally consistent within the uncertainties. This value contrasts with the redshift presented by Zhao et al. ($z = 0.282$). However, since the authors did not publish any indication on the uncertainty associated with their measure, we are not able to directly compare the two estimates.

5 Summary and Conclusions

In order to probe the physical association of the alleged low redshift quasar pair J1524QS present in the VCV10 catalogue, we have observed the two sources with the Asiago telescope. The optical spectrum of J1524S shows a number of absorption features typical of a G spectral type star, ruling out the quasar classification proposed by Zhao et al. (2000) for this object.

It is worth noting that some other similar reclassification of alleged quasars in the Véron-Cetty & Véron catalogues are present in the literature (e.g., Decarli et al. 2009; Cupani et al. 2011). Moreover Flesch (2012) shows that $\sim$ 450 quasars listed in the

catalogue have erroneous astrometry by more than 8″ or are incorrect duplication of the same objects. This suggests that, for the study of binary systems, one must take special care when considering the classification, the position, and the redshift of the sources listed in this catalogue,especially when no spectrum is publicly available.

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Table 1 Properties of the detected emission lines in the spectra of J1524Q. Element (01); peak wavelength of the line (02); rest frame FWHM (03); rest frame equivalent width of the line (04); and estimated redshift (05)

line (01)	λ_{peak} [Å] (02)	FWHM [km/s] (03)	EW [Å] (04)	z (05)
$[\mathrm{OIII}]_{\lambda 5008}$	6378±1	600±100	7± 1	0.2735
Hβ (broad)	6190±3	3500±200	62±12	0.273
Hγ (broad)	5530±2	3200±250	20± 5	0.274
Hδ (broad)	5226±3	3500±400	6± 2	0.274

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